Sound Level Assessment for the

Coastal Christian School
Oak Park Blvd.
Pismo Beach, CA

requested by
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1.0 Description and Criteria

The purpose of this report is to assess existing and future background sound levels due to transportation sources with potential impact on assembly or classroom spaces in the proposed school buildings at the proposed Coastal Christian School. See the location of the site in relation to significant transportation noise sources in Figure 1. Site Plan , page 4. This sound level assessment will be evaluated against community noise criteria contained in the City of Pismo Beach General Plan Noise Element. This report will describe the existing, baseline sound levels on and around the site, and future projected sound level contours on the site once the proposed project is completed. Conclusions are made about mitigation of sound for interior spaces in the proposed buildings.

With regard to land use, potential noise conflict and noise mitigation measures, the following criteria were used to evaluate the site:

1. Pismo Beach Noise Problem Overlay Zone map.

2. City of Pismo Beach Zoning Ordinance.

3. Uniform Building Code requirement for 45 dBA or less in habitable spaces.

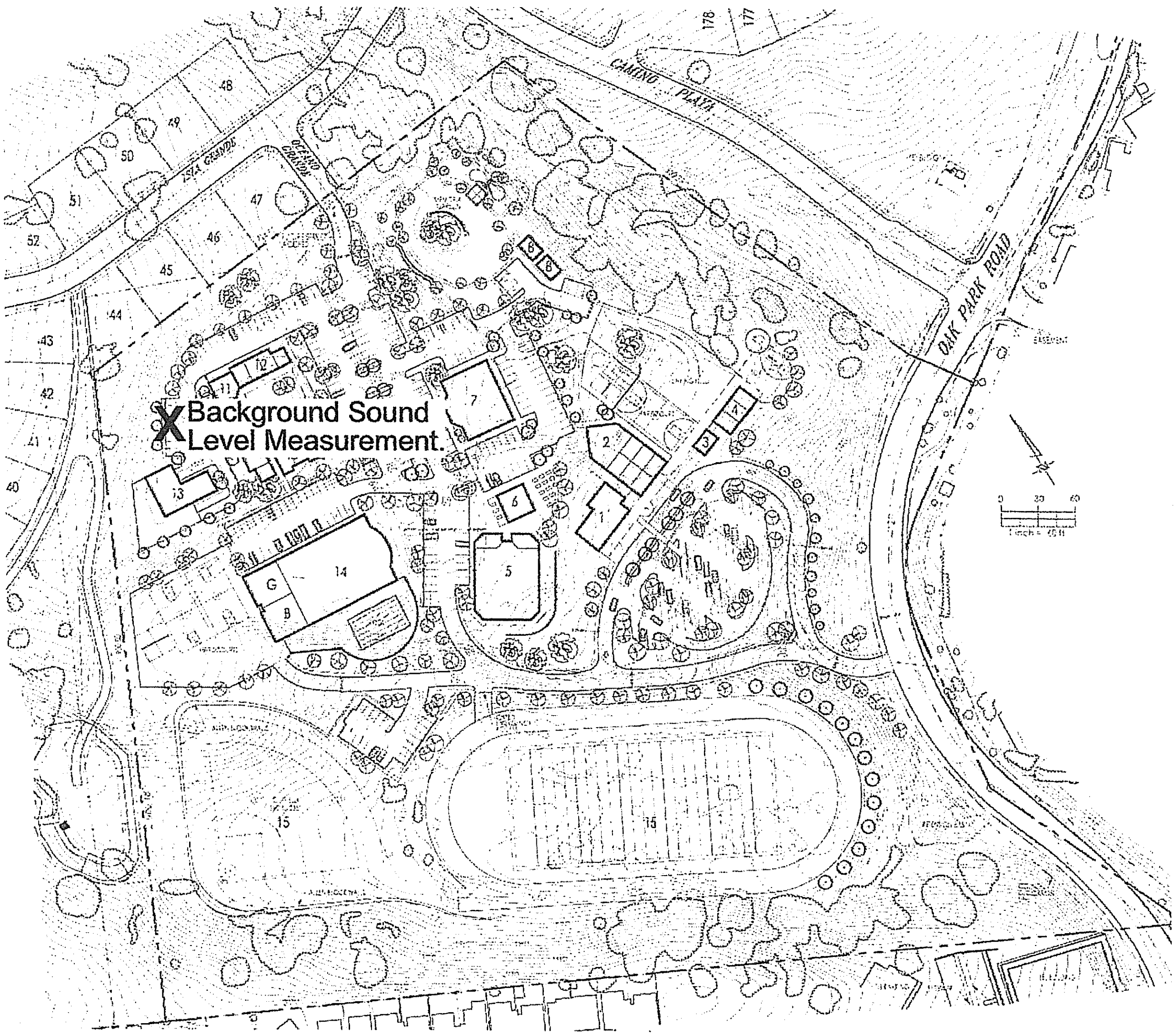
The Land Use Element and Noise Element of the General Plan for the City of Pismo Beach recognize that noise sources for residential land use areas above 60 dBA but less than 75 dBA are conditionally acceptable and should be permitted only after careful study and inclusion of noise protective measures as needed to satisfy the policies of the Noise Element.(pages 58-59) and a limit of LDN = 45 dBA for interior noise sensitive uses. Mitigation measures may be required to insure that interior spaces shall not exceed 45 dBA [Noise Element,

2.0 Existing Sound Levels

A site visit was made on June 2 and a continuous, one-hour sound level measurement was made at the position indicated on the site plan. The sound level measurement was made at a point indicated as X on Figure 1. Site Plan , page 4. The sound level measurement provided an accurate determination of the magnitude and duration of existing vehicle noise impacting primarily the east side of the proposed project. The measurements were timed to include sound levels generated by traffic on a typical weekday. The ambient measured LEQ (hourly) is an accurate depiction of existing noise conditions found in the field, as influenced by local topographical variations and built environment obstructions and reflective surfaces.

Figure 1. Site Plan

Overall site plan is shown, with the following potential transportation noise sources located to the north and east of the proposed project: Isla Grande, Camino Playa and Oak Park Road. Location of Background Sound Level Measurement is indicated.



The sound level instruments, measurement technique, and standards used are more fully described in the Appendix to this report. Wind speed data during this study was taken from the San Luis Obispo Airport weather station, located approximately 9 miles north of the site. Throughout the measurement period, wind speed was less than 10 m.p.h. Additionally, a 3.5 inch foam windscreen was used to guard against microphone wind noise at all times.

The results of the existing sound level measurement are depicted in Figure 3. Continuous Sound Level Chart on page 6. The existing average 24-hour sound level at the point of measurement is LDN = 52 dBA.

Traffic on Oak Park Road, consisting of automobiles, some trucks and motorcycles, is clearly audible along the eastern portion of the site. The traffic flows at about 30 m.p.h. and consists of about five percent truck traffic. Average Daily Traffic (ADT) count for the segment of Oak Park Road is between 2,000 and 3,000 vehicles.

3.0 Sound Level Contours

Existing contours are shown in Figure 3. Existing Sound Level Contours, on page 7. The sound level contours are generated from measured data by the "Noise Contour Modeling" technique discussed on page 13 in APPENDIX II: Measurements and Modeling Methods. The location of the contours is affected by topography, the proposed building mass, and by daily traffic volume on each of the transportation corridors, highway and rail. Day / Night Levels (LDN) in dBA are shown across the entire site, with contour lines drawn for each decibel difference.

4.0 Future Sound Levels

Future sound levels for this site will slowly increase as traffic volume increases. A projection of future growth incorporates the planned traffic circulation to the north and west of the site and acoustically modeled as shown in Figure 4. Future Sound Level Contours with Project, on page 8. The resulting future increase in sound level across the site will be less than the allowable LDN = 60 dBA across the site. Therefore the increase is less than significant.

5.0 Discussion and Conclusion.

Transportation sound levels around the proposed classroom and administrative buildings on the site are at present and in the future less than the allowable 60 dBA and will result in interior sound levels less than LDN = 45 dBA if ordinary construction materials and methods are used. Therefore noise mitigation measures are not required for this project.

Figure 2. Continuous Sound Level Chart

Results of continuous sound level measurements LEQ 1 hour = dBA.

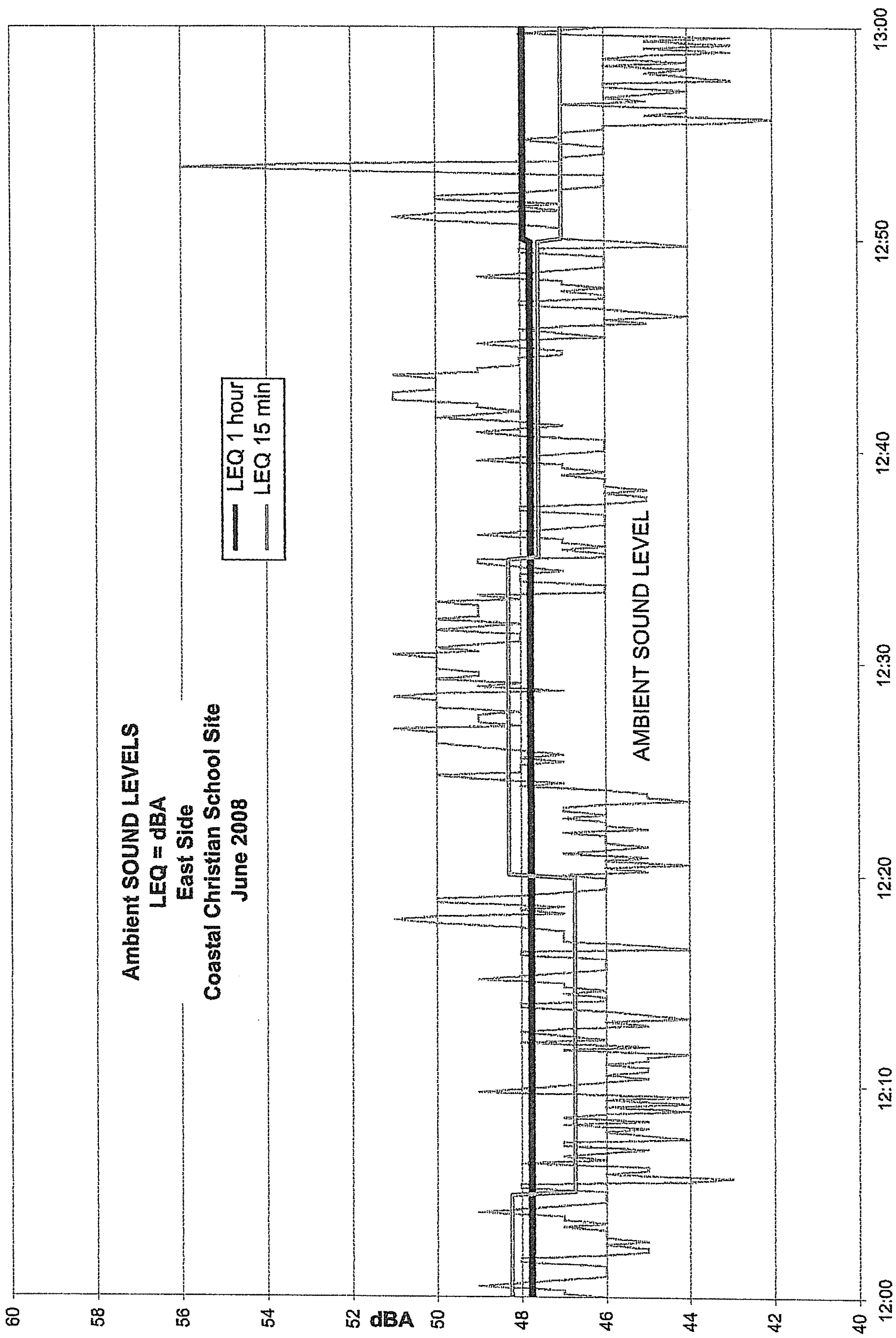


Figure 3. Existing Sound Level Contours

dBA = LDN, Sound Level Contours derived from measurements and acoustical modeling.

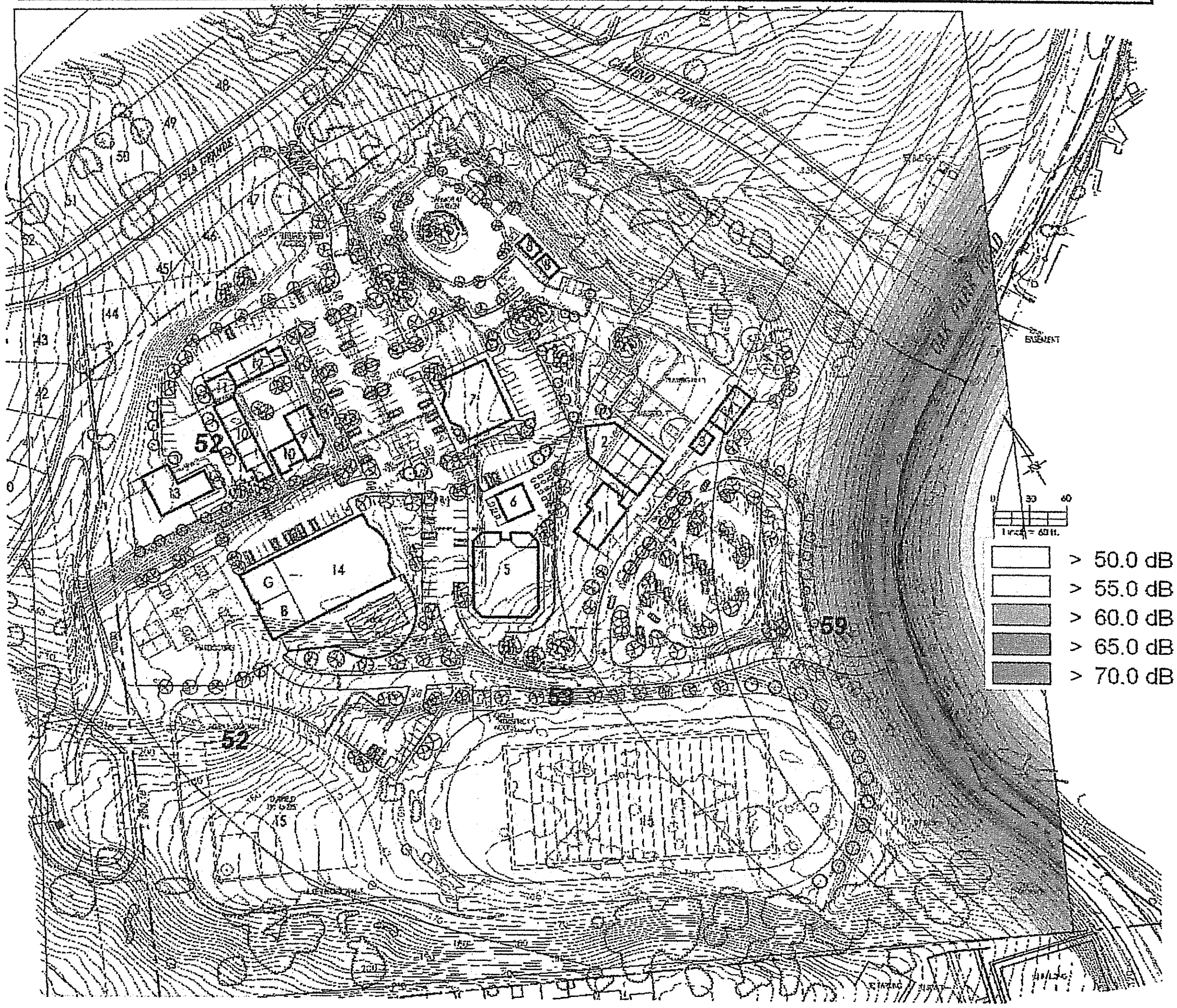


Figure 4. Future Sound Level Contours with Project

dBA = LDN, Sound Level Contours derived from measurements and acoustical modeling.

6.0 REFERENCES

1. American National Standards Institute, Inc. 2004. *ANSI 1994 American National Standard Acoustical Terminology.* ANSI S.1.-1994, (R2004) , New York, NY.

2. American Society for Testing and Materials. 2004. *ASTM E 1014 - 84 (Reapproved 2000) Standard Guide for Measurement of Outdoor A-Weighted Sound Levels.*

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4. Bolt, Beranek and Newman. 1973. *Fundamentals and Abatement of Highway Traffic Noise*, Report No. PB-222-703. Prepared for Federal Highway Administration.

5. California Department of Finance. 2007. *California Strategic Growth Plan.*

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8. ______. 2006. *California Transportation Plan 2025*, chapter 6.

9. California Resources Agency. 2007. *Title 14. California Code of Regulations* Chapter 3. Guidelines for Implementation of the California Environmental Quality Act Article 5. Preliminary Review of Projects and Conduct of Initial Study Sections, 15060 to 15065.

10. Federal Highway Administration. 2006. *FHWA Roadway Construction Noise Model User's Guide Final Report.* FHWA-HEP-05-054 DOT-VNTSC-FHWA-05-01.

11. Harris, Cyril.M., editor. 1979 *Handbook of Noise Control.*

7.0 APPENDIX I: Notes, Definitions

TERM	DEFINITION
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise or sound at a given location. The ambient level is typically defined by the LEQ level.
Background Noise Level	The underlying, ever-present lower level noise that remains in the absence of intrusive or intermittent sounds. Distant sources, such as traffic, typically make up the background. The background level is generally defined by the L90 percentile noise level.
Sound Level, dB	Sound Level. Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of 20 micropascals, SLOW time response, in accordance with ANSI S1.4-1971 (R1976) Unit: decibels(dB).
dBA or dB(A):	A-weighted sound level. The ear does not respond equally to all frequencies, but is less sensitive at low and high frequencies than it is at medium or speech range frequencies. Thus, to obtain a single number representing the sound level of a noise containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dBA. The A-weighted sound level is also called the noise level.
Equivalent Sound Level LEQ	Because sound levels can vary markedly in intensity over a short period of time, some method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, one describes ambient sounds in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy-equivalent sound/noise descriptor is called LEQ. In this report, both a 15 minute and an hourly period is used.
Percentile Sound Level (Ln)	The noise level exceeded during n percent of the measurement period, where n is a number between 0 and 100 (e.g., L90)
Subjective Loudness Changes.	In addition to precision measurement of sound level changes, there is a subjective characteristic which describes how most people respond to sound: •A change in sound level of 3 dBA is *barely perceptible* by most listeners. •A change in level of 6 dBA is *clearly perceptible*. •A change of 10 dBA is perceived by most people as being *twice* (or *half*) as loud.
Time weighting	Different, internationally recognized, meter damping characteristics are available on sound level measuring instruments: Slow (S), Fast (F) and Impulse (I). In this community sound level measurement, the Fast (F) response time is used.

8.0 APPENDIX II: Measurements and Modeling Methods

Wind Measurement

Sound level measurements become less reliable when average wind speed is greater than 11 m.p.h. at the measurement site. Therefore, wind speed and direction are measured periodically at the measurement site and the results are correlated with wind data from a nearby established weather station. A Larson Davis WS 001 windscreen is used as wind protection for all microphones and is left in place at all times.

Wind speed and direction were noted throughout the measurement period and compared with data from San Luis Obispo Airport weather station located approximately 9 miles northwest of the site. A magnetic compass was used to estimate wind direction. A Davis Turbo Wind meter was used to measure wind speed at the measurement site. The Turbo Wind meter is a high performance wind speed indicator with exceptional accuracy.

Sound Level Meters

Precision of Sound Level Meters. The American National Standards Institute (ANSI) specifies several types of sound level meters according to their precision. Types 1,2, and 3 are referred to as "precision," "general-purpose," and "survey" meters, respectively. Most measurements carefully taken with a type 1 sound level meter will have an error not exceeding 1 dB. The corresponding error for a type 2 sound level meter is about 2 dB. The sound level meters used for measurements shown in this report are Larson-Davis Laboratories Model 812 and Model 820. These meters meet all requirements of ANSI s1.4, IEC 651 for Type 1 accuracy and include the following features: 110 dB dynamic range for error free measurements. Measures FAST, SLOW, Unweighted PEAK, Weighted PEAK, Impulse, Leq, LDOD, LOSHA, Dose, Time Weighted Average, SEL, Lmax, Lmin, LDN. Time history sampling periods from 32 samples per second up to one sample every 255 seconds.

Field calibration of the meter is accomplished before and after all field measurements with an external calibrator. Laboratory calibration of the all instruments is performed at least biannually and accuracy can be traced to the U.S. National Institute of Science and Technology standard.

The following Type 1 Sound Level Meter was used for this study: The sound level meter is factory calibrated as three separate components; the body of the meter itself plus the preamplifier and the microphone, each of which has a Certificate of Calibration and Conformance. When calibrated, the instrument is certified as meeting factory specifications; Normal elapsed time between factory calibrations should not exceed two years.

Type 1 Larson Davis model 812 Sound Level Meter, Serial Number 0433. Factory calibrated, Certificate Number 2006-77140; Certificate of Calibration and Conformance issued 07 FEB 2008. Calibration due 07 FEB 2010; Preamp 828, Serial Number 1482 Factory calibrated, Certificate Number 2006-77138; Certificate of Calibration and Conformance issued 07 FEB 2008. Calibration due 07 FEB 2010; Microphone 2560, Serial Number 3153 Factory calibrated, Certificate Number 2006-76883 Certificate of Calibration and Conformance issued 09 FEB 2008. Calibration due 09 FEB 2010

Calibrator used in this study

Larson Davis CA250 Acoustic Calibrator, Serial Number 1931. Certificate of Calibration and Conformance, Certificate Number 2006-66284. Factory Calibrated on 01-22-2007. The instrument meets factory specifications per Procedure D0001.8192. The instrument was found to be in calibration as received. Full calibration report available on request. The above instruments meet factory specifications per ANSI S1.4 1983.

Sound Level Measurement Method

The protocol for conducting sound level measurements is prescribed in detail by the American Society for Testing and Materials (ASTM) in their E 1014 publication and the Cal Trans Traffic Noise Analysis Protocol. The procedures and standards in those documents are met or exceeded for sound level measurements shown in this report. The standards of ASTM E 1014 are exceeded by using Type 1 sound level meters for all measurements in this report instead of the less accurate Type 2 meters. Therefore, the precision of the measurements in this report is likely to be better than +/- 2 dB as stated in ASTM E1014.

Caltrans Noise Measurement Guidelines

Caltrans makes available general guidelines for taking into account environmental elements in noise measurements. The following is an excerpt from their guidelines. The Traffic Noise Analysis Protocol (hereafter referred to as the Protocol) contains Caltrans noise policies, which fulfill the highway noise analysis and abatement/mitigation requirements stemming from the following State and Federal environmental statutes:

- California Environmental Quality Act (CEQA)
- National Environmental Policy Act (NEPA)
- Title 23 United States Code of Federal Regulations, Part 772 "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 CFR 772)
- Section 216 et seq. of the California Streets and Highways Code

Wind speed and direction, temperature profiles, relative humidity, and sky conditions can cause changes in noise measurement results at normal receiver distances from the highway. Information concerning these effects is made part of the documentation accompanying the noise measurement data. Without it, there is no baseline against which subsequent measurements can be compared. The prevailing wind direction is expressed in degrees clockwise from the north direction, or it can be expressed as a direction on a 16-point compass, where north is 0 degrees, east is 90 degrees, south is 180 degrees and west is 270 degrees. Wind, air temperature, and humidity observations are ideally made at the average height above the ground that noise is traveling between the source and the receiver. The minimum height should is at least 1.5 meter, or 5 feet, above the ground. In addition to the wind, temperature and humidity observations, sky conditions are also documented.

Meteorological conditions can affect noise measurements in two ways: they can affect the measurement instruments directly, or they can affect the actual noise levels. Wind speeds of 5 meters per second, or 11 miles per hour, create a wind noise of about 45 dBA on a typical ½" microphone with windscreen. This means that measurements of noise below 55 dBA will be contaminated under these conditions. Extreme hot or cold temperatures and humidity can also affect the operation of noise measurement instruments. High humidity or rapid changes in temperature can cause droplets of moisture to form on the microphone diaphragm, creating a popping noise. This can contaminate the noise measurement. Rain, or wet pavement will change tire-pavement noise characteristics, altering traffic noise both in level and frequency. Changes in wind speed and direction relative to the location of the noise source and receiver can cause changes in the magnitude and direction of wind shear. This can result in refraction effects that can redirect sound energy away from or toward a receiver and change overall noise levels.

For normal highway traffic noise measurements, meteorological conditions are restricted as follows: If wind speeds, regardless of direction, are greater than 5 meters per second, or 11 miles per hour, those measurements are not included in the noise analysis. For research or special studies this criterion is often lower, depending on the objectives of the study. Temperatures and humidity are within the operational ranges specified for the equipment used. [reference: Caltrans Traffic Noise Analysis Protocol For New Highway Construction and Highway Reconstruction Projects, October, 1998]

Roadway Traffic Noise Analysis

The traffic noise data was used to calibrate the noise modeling program using the algorithms of the Federal Highway Administration Highway Traffic Noise Model (TNM 2.5). The TNM 2.5 model is the analytical method currently favored for traffic noise prediction by most state and local agencies. It is applied to federal and state roadway projects by the California Department of Transportation (Caltrans). The model is based upon the CALVENO noise emission factors for automobiles, medium trucks and heavy trucks, with consideration given to vehicle volume, speed, roadway configuration, distance to the receiver, and the acoustical characteristics of the project site. In addition, sound level measurements were performed over 24-hour periods at two locations to describe ambient sound levels in the project area, and to derive suitable LDN day/night traffic noise distribution factors for traffic noise modeling.

Noise Contour Modeling

Noise contours incorporating the measured sound level values were generated using CADNA/A, an acoustical modeling program that incorporates the TNM 2.5 algorithms, and which was developed to predict hourly Leq values for free-flowing traffic conditions. This computer modeling tool, made by Datakustik GmbH, is an internationally accepted acoustical modeling software program, used by many acoustics and noise control professional offices in the U.S. and abroad. The software has been validated by comparison with actual values in many different settings. The program has a high level of reliability and follows methods specified by the

International Standards Organization in their ISO 9613-2 standard, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation." The standard states that, "this part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level … under meteorological conditions favorable to propagation from sources of known sound emissions. These conditions are for downwind propagation … under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night."

The computer modeling software takes into account source sound power levels, surface reflection and absorption, atmospheric absorption, geometric divergence, meteorological conditions, walls, barriers, berms, and terrain variations. The CADNA/A software uses a grid of receivers covering the project site.

9.0 Qualifications of Preparer

David Lord, Ph.D., Principal Consultant

For more than 20 years, David Lord has worked with architects, engineers, building contractors and public agencies to assess and solve problems in acoustics, noise and vibration. Dr. Lord is recognized as an acoustical consultant by several municipal and county planning departments and has provided acoustical consulting services for projects located in the following counties in California: San Luis Obispo, Santa Barbara, Orange, San Bernardino, Ventura and Los Angeles. David Lord is approved by the Department of Defense as an acoustical consultant at Vandenberg Air Force Base and at the Naval Facilities Engineering Command, Port Hueneme.

Community Noise Assessment

Projects have ranged in scale and complexity from residential to commercial and institutional developments. All noise assessments rigorously follow Caltrans and ASTM standard procedures, while adhering to local planning standards and noise ordinances and the Uniform Building Code. Recent projects include: Environmental Impact Report noise chapter for a Metrolink station in Orange County; noise assessment for an automobile service center, a retail food market, a community theater, a water treatment plant, various wineries, a boutique hotel, a remote, 600 acre religious retreat site, an annual rodeo and tractor pull event, a metal salvage yard, etc. Residential neighbor-noise assessments range from animal noise to motorcycle noise, to stationary mechanical noise issues.

Room Acoustics

Consulting projects undertaken in room acoustics range in scale from 50- to 400-seat spaces, such as church sanctuaries and restaurants. Consultation begins preferably with the architect early in design and continues through construction and occupancy. Music sources are evaluated and matched to the shape, the volume and the absorptivity of the space, using energy/time/frequency analysis tools. Recent projects include the Katsuya Restaurant at Hollywood and Vine; the Vina Robles Winery Refectory, and the United Methodist Church, San Luis Obispo.

Instrumentation

Sound and vibration measurements are made with multiple, state-of-the-art, data-logging, integrating, Type I instruments and a real time analyzer. Long-term total sound monitoring is conducted with high-resolution digital sound recorders. Sound transmission and reverberation studies are made with a real-time analyzer following ASTM procedures. Each instrument is factory calibrated annually to meet U.S. National Institute of Standards and Technology requirements and has a current Certificate of Calibration and Conformance.

Recent Projects in California. Partial list; References provided on request.

1. Bradley Square, Santa Maria, California; Housing Development 120 units. Transportation noise assessment, mitigation recommendations, noise-resistant construction design.

2. Por La Mar Nursery commercial horticulture development, worker housing, Santa Barbara / Goleta, California. Transportation noise assessment, noise resistant housing design.

3. Fess Parker Wine Center, Lompoc California, with Pults & Associates, Architects. CEQA Environmental Impact Assessment for Noise, City of Lompoc.

4. San Ysidro Ranch, Montecito, with Mechanical Engineering Consultants, Santa Barbara. Total sound level monitoring, recording, assessment and mitigation design.

5. Santa Maria Country Club, Santa Maria, California; room acoustics solutions for conference, dining and meeting rooms.

6. State Street, City of Santa Barbara, consultant to several entertainment establishments for entertainment noise mitigation and conflict resolution.

7. Expert testimony for Allen Hutkin, Attorney at Law, San Luis Obispo, noise nuisance cases.

8. Environmental Impact Report, Noise Impact Assessment for Enos Ranchos and Mahoney Ranch General Plan Amendment/Zone Change/Specific Plan Amendment/Annexation, Santa Maria, CA, with Science Applications International Corporation (SAIC)

9. Environmental Impact Report, Noise Impact Assessment, including rail noise issues, for Westgate Metrolink Station, Placentia, CA, with Crawford, Multari and Clark Associates.

10. Expert testimony for William S. Walter, Attorney, eminent domain compensation case, San Luis Obispo, CA.

11. QAD Inc., Summerland, CA. Chiller installation noise assessment and mitigation design evaluation to meet County of Santa Barbara noise standards.

Academic Qualifications

David Lord is a Professor Emeritus of Architecture at California Polytechnic State University, San Luis Obispo, where he developed the curriculum and taught courses in community noise and acoustical engineering.

David Lord holds the Master of Architecture degree from the University of California, Berkeley, with a specialization in architectural acoustics. David Lord earned the Ph.D. degree from the University of London, Bartlett School of Architecture.

Memberships

David Lord is a member of the American Society of Heating, Refrigerating and Air Conditioning Engineers, the Acoustical Society of America, the American Institute of Physics, the Institute of Noise Control Engineering, and the Audio Engineering Society.